A PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF DISPLACED DISTAL FEMORAL FRACTURES INTERNALLY FIXED USING LOCKING COMPRESSION CONDYLAR PLATES

Dissertation submitted to

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for the award of the degree of

M.S. DEGREE BRANCH - II
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CERTIFICATE

This is to certify that **Dr. C. ARUNKAMAL,** Postgraduate student (2005-2008) in the department of orthopaedics, Government Kilpauk Medical College, Chennai has done this dissertation on **"A PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF DISPLACED DISTAL FEMORAL FRACTURES INTERNALLY FIXED USING LOCKING COMPRESSION CONDYLAR PLATES"** under my guidance and supervision in partial fulfillment of the regulation laid down by the Tamilnadu Dr. M.G.R. Medical University, Chennai for MS (Orthopaedics) degree examination to be held on March 2008.

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DECLARATION

I, **Dr. C. ARUNKAMAL,** solemnly declare that dissertation titled **"A PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF DISPLACED DISTAL FEMORAL FRACTURES INTERNALLY FIXED USING LOCKING COMPRESSION CONDYLAR PLATES"** is a bonafide work done by me, at Government Kilpauk Medical College between 2005-2008, under the guidance and supervision of my unit **Chief Prof. Dr. A. SIVAKUMAR, M.S. (Ortho.,) D. Ortho.,** Professor of Orthopaedic Surgery.

This dissertation is submitted to Tamilnadu Dr. M.G.R. Medical University, towards partial fulfillment of regulation for the award of M.S. Degree (Branch – II) in Orthopaedic Surgery.

Place : Chennai

Date :   **(Dr. C. ARUNKAMAL)**

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CONTENTS

INTRODUCTION

Fractures of the distal femur are complex injuries. They can produce significant long term disability. They account for 7% of all femoral fractures. If hip fractures are excluded, 31% of femoral fractures involve distal portion[23,24].

Although open reduction and internal fixation with plates and screws has become a standard method of treatment for many types of fractures, the management of comminuted, intra articular distal femoral fractures still remains complex and challenging to the orthopaedic surgeon. Many of these fractures are the result of high energy trauma which generates severe soft tissue damage and articular and metaphyseal comminution. The incidences of malunion, non-union and infection are relatively high in many reported series.

Coronal plane fractures and extensively comminuted fractures preclude the use of commonly used devices like 95° Condylar blade plate, the Dynamic condylar screw with 95° side plate and supracondylar nails[11,12]. Lateral buttress or neutralization plate may be used, but when this device is applied in presence of medial comminution or bone loss, failure of fixation and varus collapse may eventually result.

Recent advances in technology for the treatment of distal femoral fractures include the less invasive stabilization system (LISS)[7,8,9] and the locking compression Condylar plates. They offer multiple points of fixed angle contact between the plate and screws in distal femur, reducing the tendency for varus collapse and at the same time afford better stability[15] .

AIM OF THE STUDY

The aim of the study is to “Prospectively analyse the functional outcome of displaced distal femoral fractures, internally fixed using locking compression condylar plates” at the department of orthopaedics and traumatology, Government Royapettah Hospital, Government Kilpauk Medical College, Chennai between May 2005 and September 2007.

REVIEW OF LITERATURE

HISTORICAL REVIEW

In 1770, LAPEJODE AND SIORE first used brass wire to internally fix long bone fractures. Different techniques and methods of internal fixation were used, with mixed success between 1770 to 1965.

In 1965 MULLER, suggested L-shaped compression plate (ASIF condylar plate). Later on in 1966, MARCUS J. STEWART, SISK and WALLACE retrospectively reviewed 213 supracondylar and intercondylar femur fractures and recommended, two pin traction as the treatment of choice. In 1970, A.O. methods of internal fixation became popular and OLERUD (1972), reported 93% satisfactory results in fractures treated with blade plates, but the procedure was technically demanding with high rate of inadequate fixation which resulted in refracture after plate removal. The failure rate was high especially in osteoporotic bone.

In 1986 REGAZONNI, RUEDI and ALLGOWER used the Dynamic condylar screw implant system for fractures of the distal femur, but the main disadvantage of condylar screw implant was that the insertion of condylar lag screw requires removal of a large amount of bone which made revision surgery more difficult and varus collapse was a recognized complication. In 1991, SANDERS. R., SWIONTKOWSKI, used double plating for comminuted, unstable fractures of distal femur.

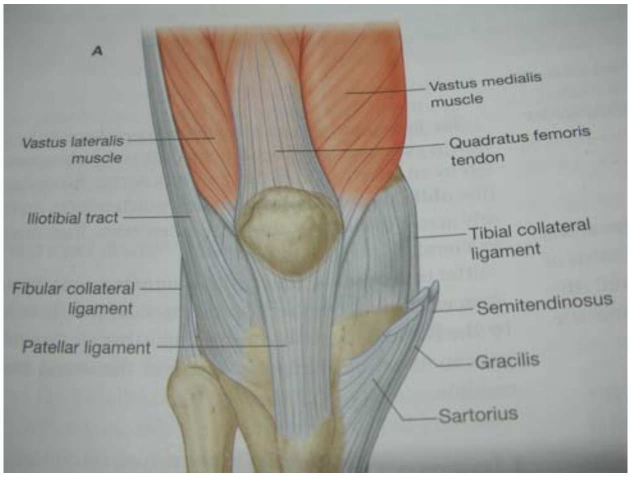
In 2000, LCP was approved as new AO plate standard

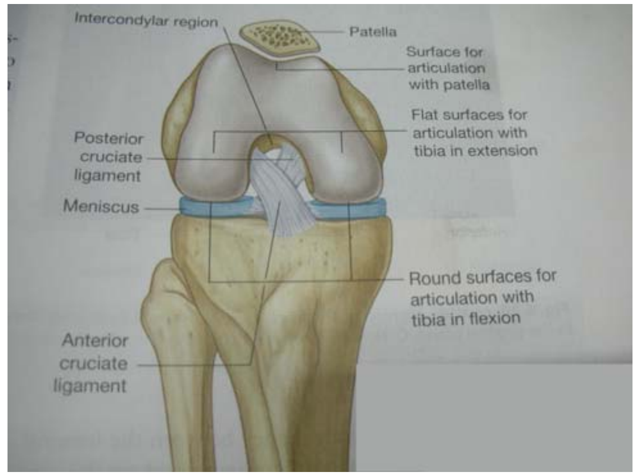
APPLIED ANATOMY[23,24,26]

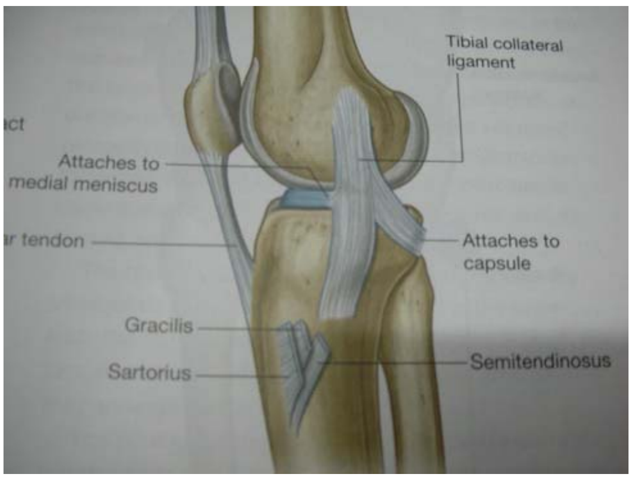
The supracondylar area of femur is defined as, the zone between the femoral condyles and the junction of the metaphysis with the femoral shaft. At junction of distal femoral diaphysis and the metaphysis, the femur flares into two curved condyles. The anterior surface, between the two condyles, has a shallow depression for articulation with the patella. The posterior surface is separated by a deep intercondylar fossa. The lateral condyle is broader than the medial condyle and projects forward helping to stabilize the patella. The medial condyle is longer and extends farther distally than the lateral condyle and is convex medially. When viewing the lateral surface of distal femur, it is observed that the shaft is aligned with the anterior half of the condyles. On axial view, the condyles are wider posteriorly, thus giving a trapezoidal shape to the distal femur.

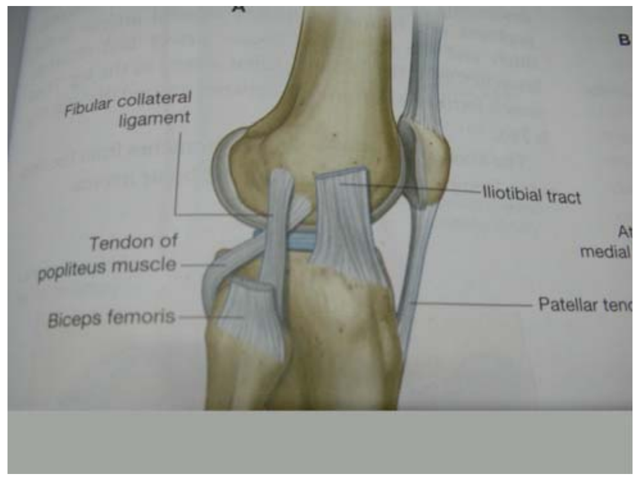
The knee joint is a complex synovial joint of modified Hinge variety. It is a compound joint that includes two condylar joints between the femur and the tibia and a saddle joint between the patella and the femur. Here the flexion and extension take place around a transverse axis, but the axis is not constant. In fully

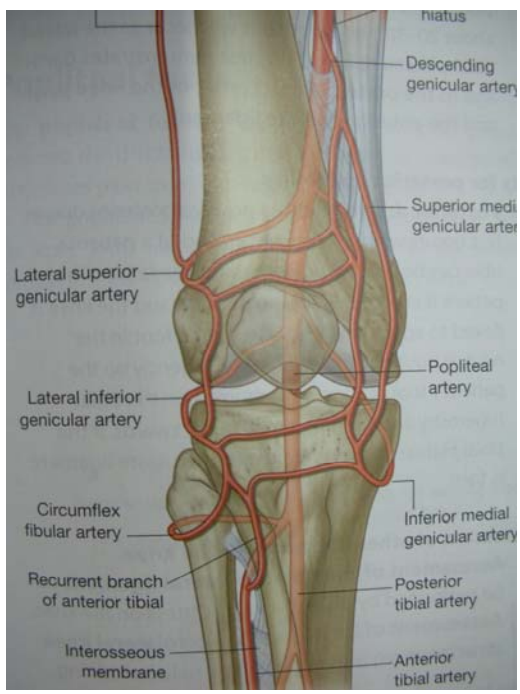
ANATOMY AROUND KNEE











extended position, the tibial tubercles are lodged in the intercondylar notch and the menisci are tightly wedged between the femoral and tibial condyles. The quadriceps muscle is the main extensor of the knee consisting of four heads (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius). The vastus medialis is the most important component responsible for the last 10 degrees of extension. Postoperative or posttraumatic arthrofibrosis of the knee occurs in patients who have had the knee immobilized for a prolonged period, resulting in severe compromise to knee function. The femoral artery passes into the popliteal fossa approximately 10 cm above the knee joint.

The Patello femoral joint is part of the quadriceps mechanism, the patella is anchored distally to the tuberosity of the tibia by the patellar tendon and superficially to the tendon of quadriceps muscle, and by medial and lateral retinacula to knee joint capsule.The patella increases the leverage of the quadriceps muscle.

The attachments on the lateral condyle are

a) The **fibular collateral ligament** of the knee joint.

b) The **popliteus tendon**

c) The **lateral head of gastrocnemius.**

The attachments on the medial condyle are

a) The **tibial collateral ligament** of the knee joint

b) The adductor tubercle at lower end of medial supracondylar line receives the **insertion of hamstring part (ischial head) of adductor magnus.**

c) Medial head of gastrocnemius

The attachments on the intercondylar notch

a) **ACL** is attached to the posterior part of the medial surface of the lateral condyle

b) **PCL** is attached to anterior part of the lateral surface of the medial condyle

c) The intercondylar line provides attachment to the **capsular ligament** and laterally to the **oblique popliteal ligament.** The anatomic axis of knee joint has a valgus angulation of **9 degrees**.

Nutrient Artery to femur

This is derived from the second perforating artery. Nutrient foramina located on the medial side of the linea aspera and is directed upwards. There is no artery entering distal femur, but has abundant blood supply through genicular vessels, of which the middle genicular supplies the cruciate ligaments.

Ossification

Excepting the clavicle, the femur is the first long bone to ossify. Femur ossifies from **1 primary and 4 secondary centres.** The primary centre for the shaft appears in 7^{th} week, of I.U. life. The secondary centres appear, one for lower end at the end of 9^{th} month of I.U. life. This is the major growing end of the bone. A centre appears in head during first 6 months of life, one for greater trochanter during 4^{th} year and one for lesser trochanter during 12^{th} year. There are 3 epiphysis at the upper end and one epiphysis at lower end, that fuses by the 20^{th} year. Patella ossifies from several centres which appear during 3-6 years of age, fusion complete at puberty.

CLASSIFICATION OF DISTAL FEMORAL FRACTURES

Fractures of the distal femur involve distal 9-15 cms of the femur including the distal femoral metaphysis (supracondylar) and the articular surface of the distal femur (intracondylar).

A good classification system for fractures of the distal femur should:

1. Distinguish among the many possible injuries to this area, including extra articular, intra articular and isolated condylar lesions.

2. Allow different surgeons consistently and reliably to grade a fracture pattern into one of the classification groups.

3. Assist in deciding the optimal method of treatment for the injury.

4. Correlate with the findings of outcome analysis to allow estimation of prognosis for each injury pattern.

NEER classified into 3 groups, but did not take into account associated intra articular fractures and the possibility of articular incongruity[1].

Group I **:** Minimum displacement, impacted, linear or slightly displaced, but stable after closed reduction.

Group II A : Condyles displaced medially, violent force applied to the anterolateral aspect of the flexed knee, oblique fracture extending from just proximal to the lateral epicondyle to well above the medial epicondyle.

Group II B : Condyles displaced laterally, severe force applied to the lateral side of the extended limb; the shaft is displaced medially, and when the fracture is open, it penetrates the skin on the inner aspect of thigh, spares extensor tendon.

Group III : Conjoined supracondylar and shaft fractures, high energy trauma to the anterior aspect of the flexed knee, when open, penetrates the skin superior to patella.

SEINSHEIMER CLASSIFICATION[2]

Into four types addressing articular disruption.

Type 1 : Nondisplaced fracture or those with less than 2 mm of displacement

Type 2 : Fractures involving the distal metaphysis only, without intraarticular extension

a) Two part

b) Comminuted

Type 3 : Fractures involving the inter condylar notch in which one or both condyles are separate fragments

a) medial separate

b) lateral separate

c) both condyles separated from the shaft and from each other

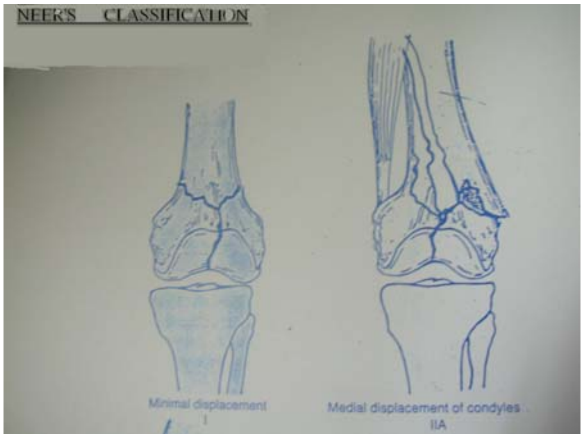
Type 4 : Fractures extending through the articular surface of a femoral condyle

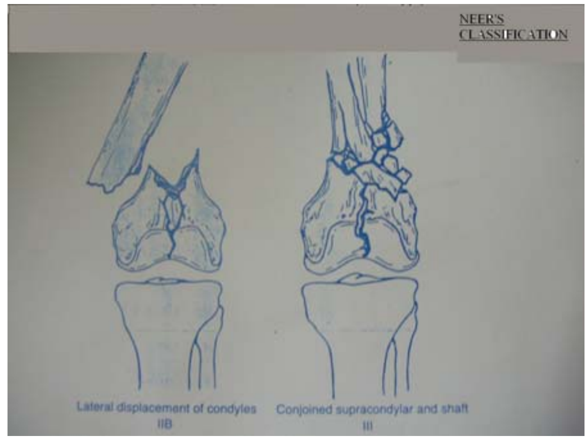
a) through medial condyle (two-part or comminuted)

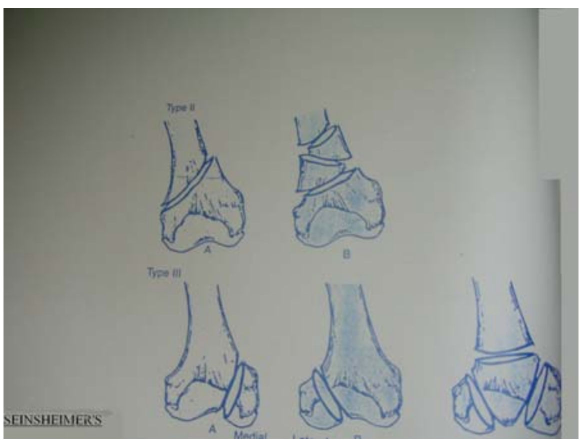
b) through lateral condyle (two part or comminuted)

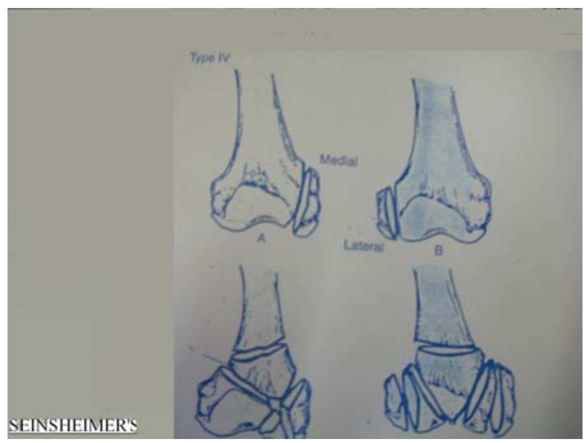
c) complex and comminuted

CLASSIFICATION









ORTHOPAEDIC TRAUMA ASSOCIATION CLASSIFICATION OF DISTAL FEMORAL FRACTURES (OTA) DEVELOPED BY MULLER[23]

Defines the fracture (extra – or – intraarticular, comminution, indicates prognosis, and helps to decide the type of treatment.

Type A : Extraarticular

A1: Simple (two part)

A2 : Metaphyseal wedge

A3 : Metaphyseal complex (comminuted)

Type B : Unicondylar, partial articular

B1 : Lateral condyle, sagittal

B2 : Medial condyle, sagittal

B3 : Frontal (coronal plane)

Type C : Intercondylar / bicondylar, complete articular

C1 : Articular simple, metaphyseal simple

C2 : Articular simple, metaphyseal complex

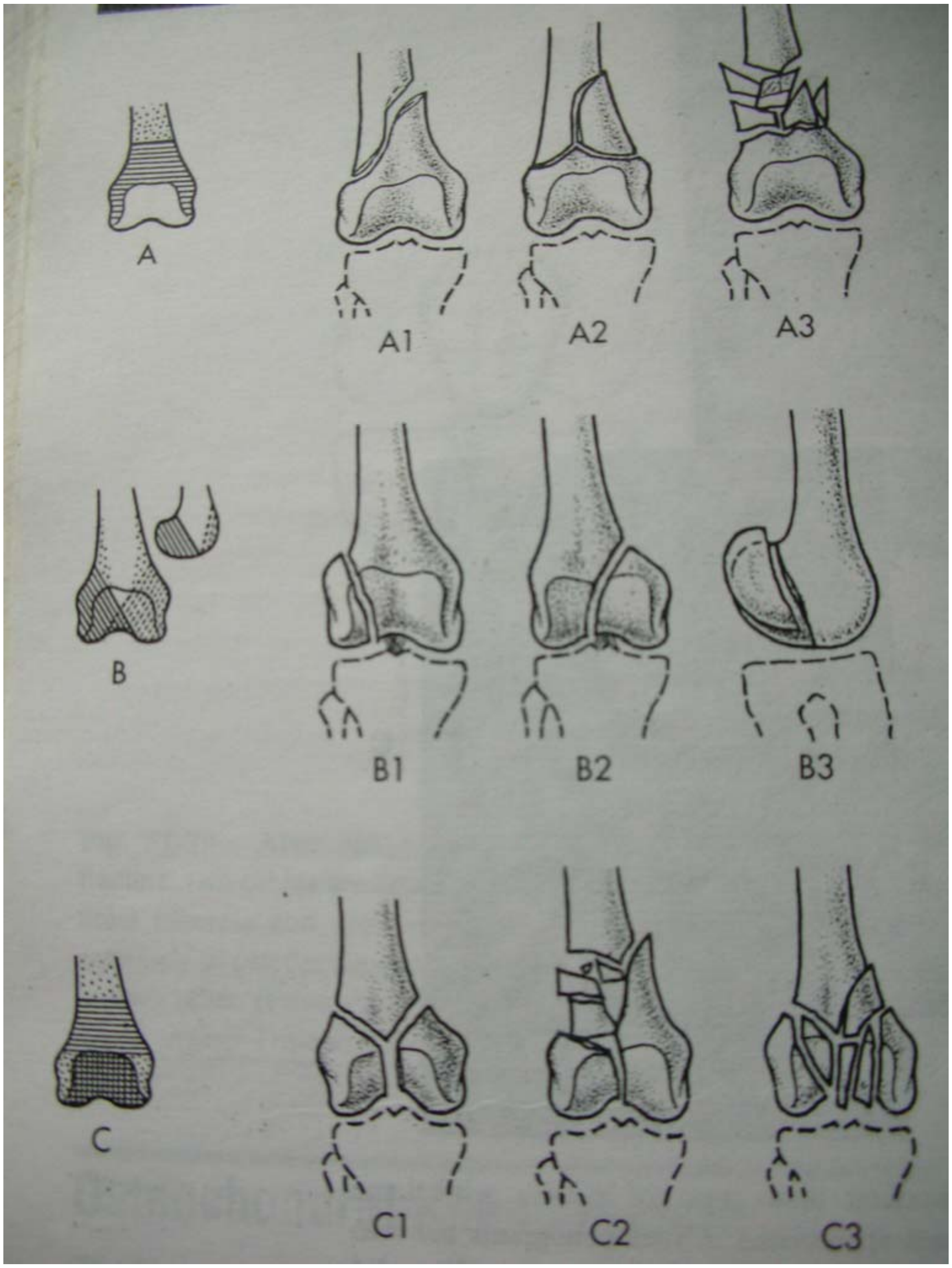
C3 : Multifragmentary articular fracture

Descriptive Classification[24]

- Open Vs Closed
- Location - supra condylar, inter condylar involvement
- Pattern - spiral, oblique, or transverse
- Articular involvement or not
- Angulation - varus, valgus, or rotational deformity
- Displacement - shortening or translation
- Comminution, segmental, or butterfly fragment

We followed OTA classification, developed by Muller[23] because of its simplicity, reproducibility and wide acceptance among the orthopaedic surgeons.

CLASSIFICATION



MECHANISM OF INJURY IN DISTAL FEMUR FRACTURES

The mechanism of Injury in most cases is axial loading with valgus or varus or with rotational forces[1,2]. The force acting direct over the distal femur also produces fractures. The deformities are produced primarily, by the direction of the initial fracture displacement and secondarily, by the pull of the thigh muscles. Pull of the hamstrings and quadriceps lead to limb shortening and angulation at the fracture site[23,24]. Adductor muscles produce varus deformity, contraction of the gastrocnemius muscle produces posterior angulation. In fractures with intercondylar extension, muscle attachments to the respective condyles tend to produce splaying and rotational malalignment. Open fractures occur in 5-10 % of all supracondylar fractures. The most common site for the open wound is over the anterior thigh proximal to the patella.

High energy - Young patients, sustain injury after high energy,

ex: motor vehicular trauma.

Low energy - Elderly patients may sustain fractures through osteoporotic bone, after relatively minor trauma, such as a fall onto a flexed knee. Varus / valgus stress forces with axial load and rotational components play a significant role in producing these fractures.

In our study, 12 out of 20 cases resulted from road traffic accidents, 5 cases due to fall from height and the rest due to trivial injury in osteopenic bone.

CLINICO-RADIOLOGICAL EVALUATION

A detailed history should be taken, to ascertain the mode of violence and to correlate the fracture pattern and to anticipate hidden complications. This being followed by a detailed full trauma evaluation. About 1/3 rd of younger patients are polytraumatised and in only one fifth of cases, present as isolated injury. Vascular lesions are found in about 3% cases and nerve injuries in about 1%. Lesions of menisci and osteochondral fractures are observed in 8-12%, while associated fracture of patella in approximately 15%[23,24].

Patients may typically present nonambulatory with pain, swelling, and variable deformity in the supracondylar region of the femur. Gross mobility may be present at the fracture site with crepitus. Immediate assessment of neurovascular status is mandatory. The proximity of neurovascular bundles to the fracture site is an important consideration. Any unusual and tense swelling in the popliteal area and the usual signs of pallor and lack of pulse suggest rupture of a major vessel; in these cases, angiography may be necessary.

Any clinical suspicion of compartment syndrome, must be followed by monitoring compartment pressures and assessing hemodynamic instability.

Examination of ipsilateral hip, knee, leg and ankle, are warranted, especially in the obtunded or polytraumatized patient.

In cases in which a distal femoral fracture is associated with an overlying laceration or puncture wound, saline or methylene blue may be injected into the knee in a sterile fashion to determine continuity with the wound.

Radiographs

Anteroposterior, lateral and two oblique radiographs of affected extremity should be taken. Traction views may be helpful; 45 degree oblique views can better delineate intercondylar involvement[23,24]. Radiographic evaluation of the entire involved lower extremity is warranted, as concomitant injuries are common.

- Contralateral views may help with comparison and may serve as a template for preoperative planning.

- Computed tomography portrays the distal femur in cross – section, which helps to identify fracture lines in the frontal plane. Two and three dimensional reconstructions may also improve understanding of the fracture pattern in preparation for surgery.

- Angiography is indicated with frank dislocation of the knee as 40% of such injuries associated with vascular disruption. By contrast, the incidence of vascular disruption with isolated supracondylar fractures is between 2% and 3%.

METHODS OF TREATMENT

Nonoperative

May be useful under following circumstances

1) Nondisplaced or incomplete fractures.
2) Impacted stable fractures in elderly
3) Osteoporotic patients
4) Infected or severely contaminated fractures grade IIIb / IIIc open injuries)
5) Advanced osteoporosis
6) Advanced underlying medical complications
7) Select gunshot injuries.

- The objective is not absolute anatomic reduction but rather restoration of the knee joint axis to a normal relationship with the hip and ankle. Good to excellent results of 84% using closed methods were reported by **Neer.**

- Reduction can be obtained by application of traction placed through a **two-pin system-** one through the supracondylar fragment and the other through the tibial tuberosity. But the difficulties are, the inability to control the displaced intraarticular fragments and occasionally, the tendency of the supracondylar fragments to displace posteriorly. The potential drawbacks include varus and internal rotational deformity, knee stiffness, and the necessity for prolonged hospitalization and bedrest.

- After initial skeletal traction period of 6 – 12 weeks, Functional Bracing can be advised.

Operative Treatment[23,24]

When there is displaced intraarticular fractures and irreducible fractures with severe comminution.

Relative indications include displaced extraarticular fractures, periprosthetic fractures, marked obesity and pathological fractures.

The choice of implant is governed by operative goals. The goals are restoration of length and axial alignment both anatomic reduction and articular congruity, stable fixation and early functional rehabilitation.

Treatment options include

1) 95° Condylar Blade plate

Ideal for supracondylar fractures

It is one piece device that can provide stable internal fixation. Also superior results are produced by using indirect reduction technique by A.O. distractor, without visualising the fracture line. It provides better healing, optimal alignment and stability and precludes bone grafting. But it is a technically demanding procedure, because the surgeon is required to place the blade plate in 3 planes simultaneously.

2) Condylar Buttress plates

It is used, when severe comminution exists in lateral femoral Condyle or there are multiple intra-articular fractures in coronal and sagittal planes.

3) Intramedullary fixation

Indicated for supracondylar fractures, Zickel supracondylar nail provides good fixation in non comminuted fractures. Retrograde Interlocking, Intramedullary nailing modified by Sarvary et al, from hungary avoids open reduction, permits, early mobilization & weight bearing and nail can be left in place because no stress shielding.

4) Dynamic Condylar Screw[19,23]

Allows interfragmentary compression, for intercondylar femur fractures, but bulky at screw-plate junction, thus requiring considerable bone removal for low profile fit.

A minimum of 4 cms of distal femur is necessary so that sufficient bone is available for condylar screw insertion.

A distal block of medial condyle is also required

Successfully used in supracondylar – inter condylar fractures Types (C_1 and C_2)

5) External fixation

It may be used alone or in combination with limited internal fixation as follows:

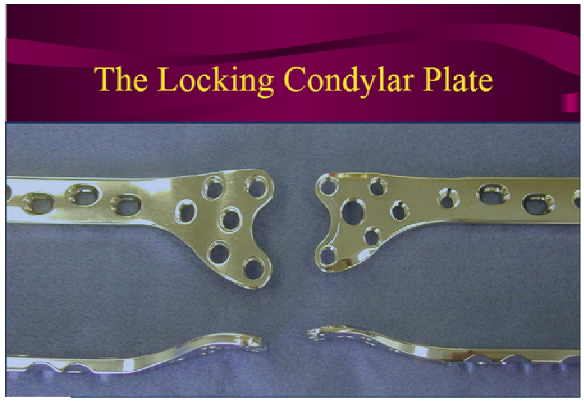
Grade I, II, IIIa Injuries can be managed with internal fixation after aggressive debridement and irrigation.

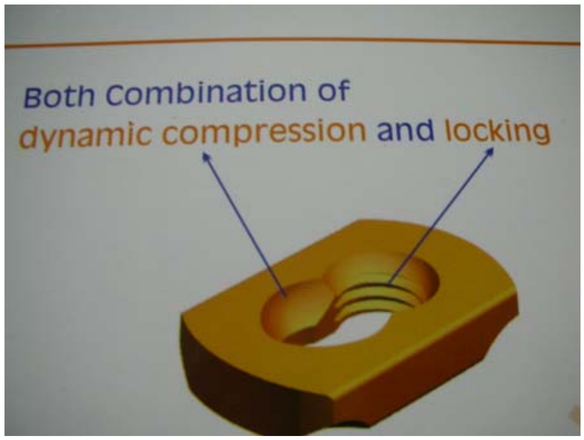
Grade IIIb and IIIc injuries should be managed with debridement, External fixation, followed by delayed internal fixation. Problems include pin-tract infection, quadriceps scarring, delayed union or nonunion and loss of reduction after device removal. Ilizarov fixator can also be used.

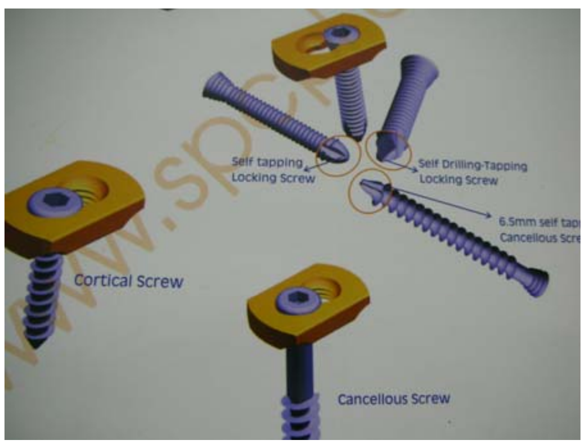
6) Locking Compression Plates (Condylar)[10,17,18,20,23,24]

Combi hole plates combines the advantages of the dynamic compression plate principle with the locking screw head principle, giving the surgeon great flexibility of choice within a single implant. The screw holes in plate have been specially designed to accept either a standard cortical screw with a hemispherical head or a locking screw with a threaded head. The locked screws also eliminated the need for fixed angle blade plates in the metaphyseal area. A locked screw plate construct can be compared to an implanted external fixator.

In traditional plating, stability is produced by compressing the plate to bone surface and engaging both cortices thereby producing a rectangular hoop with two screws. Their stability primarily depends on the friction between the plate and the bone[4,6].


The Locking Condylar Plate


Both combination of
dynamic compression and locking


Self tapping
Locking Screw
Self Drilling-Tapping
Locking Screw
Cortical Screw
Cancellous Screw


Femoral Condylar
with locked plating
Proximal Screw 6.5mm :
25mm to 95mm (Diff. 5mm)
Distal Screw 5.0mm :
12mm to 52mm (Diff. 2mm)
Holes :
4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18
Proximal Screw 5.0mm :
18mm to 52mm (Diff. 2mm)
Distal Screw 6.5mm :
25mm to 110mm (Diff. 5mm)
Indications :
Supracondylar fractures.
Distal shaft fractures.

In locking plates[25], the **periosteum is not compressed** and blood supply of bone is preserved. The locking of the screws into the plate prevents the loss of reduction primarily, at the time of fixation and also after fixation, because the **toggle of screws are avoided. The frictional force between the plate and bone is eliminated.** Also, there are provisions to put screws in different angles at the metaphyseal area further improving the stability of the construct. The locking plates are fixed angle devices, **prevents varus collapse**, prevent toggle and sequential screw loosening, particularly in osteoporotic bone[13].

In the locking system, the forces are distributed evenly over the entire contact surface of the screws in the bone and are transmitted through the contact points of the plate with bone surface. The first screw next to the fracture transmits about 50-60% of the forces, the second 20-30% and the third screw about 10%. Load transmission by additional screws is negligible.

The Condylar locking plates for femur has side differentiation & comes in precontoured and variable hole design and the combi-hole increasing its versatility and can be used in severely comminuted extra and intraarticular fractures.

The disadvantages with locking plate device are that,

1. Current locking plate design **maintains fracture reduction but does not obtain it.**

2. The surgeon has **no tactile feedback as to the quality of bone**, when tightening the screws because the screws stop abruptly when threads are completely seated into the plate regardless of bone quality.

3. Locked screws on its own will not pull the plate down to bone; hence this **lack of construct reduction capability,** combined with percutaneous plating techniques, can result in higher rates of fracture malalignment than that occur with formal open reduction and internal fixation.

4. Another concern is the **rigidity of a locked screw plate construct.** Any fracture distraction at the time of reduction or fracture resorption during healing will be held rigidly by such constructs which prevent bone to bone contact and may potentially result in delayed union or non union.

5. **No load sharing** can occur with locked screws on either side of a fracture. If the fracture is repetitively loaded, the plate eventually may fracture or fixation may be lost.

6. Some locking plate designs, **do not allow the angling of the screws** by the surgeon within the hole and still achieve a locked screw.

7. **Contouring locked plates distort the screw holes** and adversely affect the screw purchase.

8. **Hardware removal may be more difficult**, if locked screw become cold welded to the plate.

DESIGN FEATURES OF LOCKING COMPRESSION PLATES

The locking compression plates (LCP) have these LC-DCP features

- 50° of longitudinal screw angulation
- 14° of transverse screw angulation
- Uniform hole spacing
- Load (compression) and neutral screw positions
- Plates are made of 316 stainless steel
- Tapered end for submuscular plate insertion, improving tissue viability.
- Limited – contact plate design reduces plate to bone contact, limiting vascular trauma.

Locking screw design

- The screw design has been modified from standard 4.5 mm cortex screw design to enhance fixation and facilitate the surgical procedure. New features include:
    - **Conical screw head:** To provide a secure screw plate construct
    - **Large core diameter:** Improves bending and shear strength and distributes the load over a larger area in the bone.

Cortical thread profile: The shallow thread profile of the locking screws results from the larger core diameter. **Features**

- Locking screws engaged in the plate create a fixed-angle construct that improves fixation in osteopenic bone and multifragment fractures
- Multiple screw fixation in the femoral condyles
- Low-profile, anatomically-shaped plates designed for left or right femur
- 316L stainless steel implants

Plate Head (condylar region)

- ❖ Anatomically-shaped head is contoured to match the distal femur, eliminating intraoperative plate contouring
- ❖ Six threaded screw holes accept locking screws

Plate Shaft

- ❖ Combi holes combine a dynamic compression unit (DCU) hole with a locking screw hole, providing the flexibility of axial compression and locking capability throughout the length of the plate
- ❖ Straight plates available with 6, 8, 10, 12, 14, 16 or 18 Combi holes in plate shaft to accommodate fracture patterns that include shaft fractures in conjunction with articular fragments
- ❖ Curved plates are precontoured to mimic the anterior bow from the lateral aspect of the femur
- ❖ Limited-contact design-plate shaft design permits use of a minimally invasive surgical technique.

GENERAL PRINCIPLES OF INTERNAL FIXATION USING LC-DCP (COMBI HOLE PLATES)[12,17]

- Internal fixation done, using a combination of locking and standard screws.

- If a combination of cortex and locking screws is used, a cortex screw should be inserted first to pull the plate to the bone.

- If locking screws have been used to fix a plate to a fragment, subsequent insertion of a conventional screw in the same fragment without loosening and retightening the locking screw is **NOT RECOMMENDED**

- If a locking screw is used first, care should be taken to ensure that the plate is held securely to the bone to avoid spinning of the plate about the bone.

- Dynamic compression: Once the metaphyseal fragment has been fixed with locking screws, the fracture can be dynamically compressed using conventional screws in the DCU portion of the LCP hole.

- First, use lag screws to anatomically reconstruct the joint surfaces.

- A plate used as a locked plate does not produce any additional compression between the plate and the bone.

- The unicortical insertion of a locking screw causes no loss of stability.

Depending on the desired function the locking compression plate (LCP) can be applied in three different ways[12,17]:

1) As a conventional dynamic compression plate providing absolute stability **(compression technique).**

2) As a pure internal fixator providing relative stability by bridging the fracture zone according to LISS principles **(bridging technique).**

3) In combined fashion where both techniques are employed **(combination technique)** using conventional lag screws as well as locked screws.

SURGICAL TECHNIQUE FOR FIXING DISTAL FEMUR FRACTURES

Although various approaches like (1) lateral-standard

(2) minimally invasive lateral approach,

(3) medial Approach,

(4) antero-lateral approach are described.

Most surgeons prefer to use the Lateral approach-standard.

Patient position

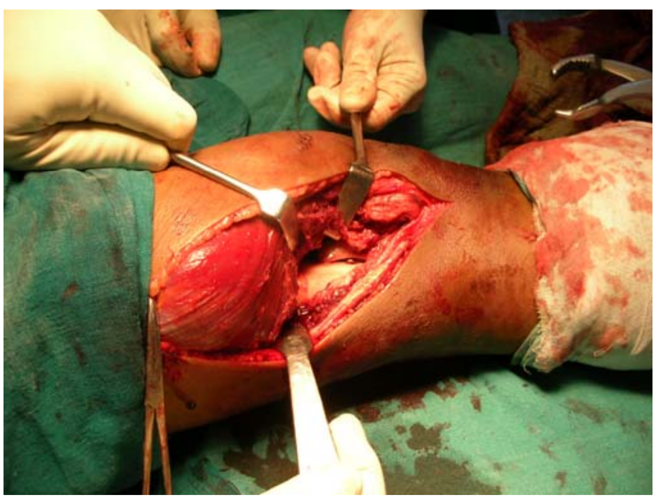
Patent is positioned supine with sandbag under ipsilateral buttock to allow slight internal rotation of the leg. The leg should be draped free, the iliac crest should be prepared and draped, if bone grafing is desired. Atternatively, patient may be placed in lateral position, based on surgeon's comfort.

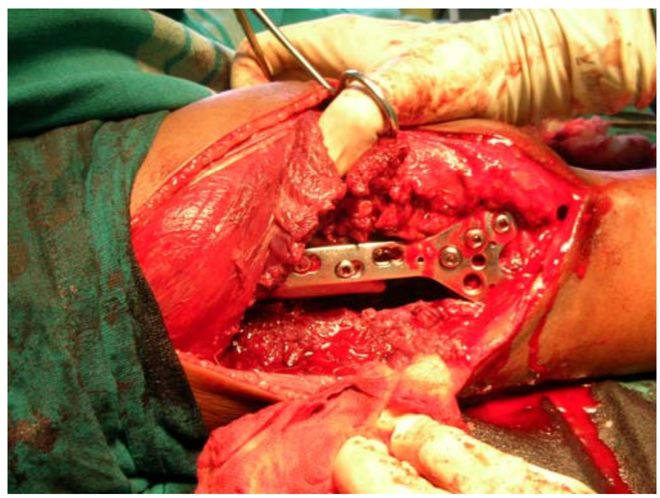
Prerequisites

- A radio-lucent operating table facilitates the use of an image intensifier during the procedure.
- Avoid using fracture table and traction because the resulting muscle tension will make exposure and reduction more difficult.
- Place a sterile bolster under knee to facilitate exposure and reduction. A sterile tourniquet may be used as a part of procedure.

In lateral approach, a single straight lateral incision is made along the thigh. Distally, the incision should extend across the midpoint of the lateral condyle anterior to fibular collateral ligament, across knee Joint and then gently curve anteriorly to end distal and lateral to tibial tubercle.

SURGICAL TECHNIQUE





Then, fascia lata is incised

- Superior geniculate artery is identified and ligated

- Care should be taken not to incise the lateral meniscus at the lateral joint margin.

- The vastus lateralis muscle carefully elevated from intermuscular septum and retracted anteriorly and medially

- Osteotomy of tibial tubercle & lifting along with patellar tendon, improves anterior exposure to the condyles of femur.

- In modified approach by Starr et al, an anterolateral skin incision is made and lateral parapatellar arthrotomy with elevation of vastus allows better visualization of the condyles.

OPERATIVE STEPS

- Reduce and temporarily secure the articular fragments with pointed reduction forceps and/or K wires. If a posterior Hoffa fragment is present, it must be reduced and provisionally stabilized with K wire inserted from anterior to posterior.

- Secure the condyles with **6.5 mm** cancellous screws. A condylar plate guide or plate itself may be held laterally on the condyle to select an area, where screws will not interfere with plate placement.

- Place a K wire across the femoral condyle, at the level of the knee, to indicate the joint axis and place a second K wire across the patello- femoral joint on the trochlear surface.

- Using anatomic landmarks and C – arm imaging, mount the plate on the intact / reconstructed condyle without attempting to reduce the proximal portion of the fracture. It is easier to thread the wire guides into the plate prior to placing the plate on the bone.

- Check whether the guide wire inserted in through the central hole is parallel to both distal femoral joint axis and patello femoral joint.

- Measure the length using measuring device. Insert screws starting from central hole in the condylar portion and check under image control.

- Self Drilling, Self Tapping Flutes of the screws make predrilling / pretapping unnecessary in most cases. In dense bone, lateral cortex may be predrilled.

- Once reduction is satisfactory, the plate may loaded in tension using articulated tension device. The plate shaft may be fixed with appropriate cortical screws after confirming final reduction of the fractures.

COMPLICATIONS

Early

1. Forceful maneuvers can induce iatrogenic fractures and complicate the fixation, especially in osteoporotic bones.

2. Damage to collateral ligaments of knee and menisci.

3. Damage to popliteal vessels, as it winds from medial to posterior compartment.

4. Damage to collateral vessels (geniculates) and accompanying nerves.

Late

1. Infection – following fixation of open fractures approach 20% and for closed fractures approaching 1%.

2. Failure of Reduction, due to improper surgical technique, poor bone stock, poor patient compliance, poor surgical planning and execution.

3. Nonunion, Malunion occurs with distal fragment in varus. The indications for a corrective osteotomy depends on the degree of malalignment and the severity of symptoms. Valgus and varus malalignment greater than 10° and / or rotational deformity greater than 15°, should be corrected.[4,5,14]

4. Knee stiffness postoperatively.

POST OPERATIVE CARE AND REHABILITATION[12,15]

Proper postoperative rehabilitation is essential to ensure the attainment and maintenance of satisfactory range of motion, strength and function of the knee joint.

Rehabilitation should be custom made to the patient and the fracture type, and is easier, more comfortable and more assured with firm internal fixation. If fracture fixation is stable, then therapy can be started early. The most useful range of motion can be achieved, in the first few weeks of postoperative period.

Early Phase (1-3 Weeks)

The primary goal is full range of motion, started on 2nd day, if fixation is stable, emphasizing extension, normal patella mobility, control of edema and pain.

- ★ Quadriceps strengthening and hamstring stretching exercises are encouraged.
- ★ Gentle hip and ankle mobilization exercises are continued.

Continuous passive motion – when started in 1st week has following advantages

1. Improves early range of motion of knee.
2. Decreases incidence of deep vein thrombosis and pulmonary embolus.
3. Faster pain relief and shorter stay at hospital.
4. Better results when used at a rate of 1 cycle per minute, with 40 degrees of maximum flexion for first 3 days.
5. Continuous passive motion reverses collagen loss, improves cartilage nourishment, prevents joint stiffness.

- ★ Non – weight bearing with crutches or walker support can be initiated in 1st week, if fixation is stable.
- ★ Sutures are removed between 10th - 12th postoperative days.

Late Phase (After 3weeks)

- ★ Continue isometric quadriceps setting exercises, Active and passive Range motion exercises.

- ★ Seated knee extension procedures.

- ★ Partial weight bearing is allowed after 3^{rd} week.

- ★ Full weight bearing is allowed after radiological evidence of healing. (6-12 weeks).

Patients with inter condylar fractures and A-0.types B and C fractures are not allowed full weight bearing for at least 12 weeks.

GOALS OF REHABILITATION

- ➢ Based on the observation that 65° - 70° flexion, is required in the swing phase of normal gait, 90° knee flexion required to ascend and descend stairs and 105º flexion required to raise early from a low chair and to tie one's shoes[2,3]. Most recommend continuous passive motion for 3 hours daily for 2-3 weeks, till the patient achieves more than 100º flexion.

- Periodic monitoring of knee flexion at end of 1st, 2nd, 3rd, week and after completion of therapy, with concomitant isometric quadriceps exercises and knee mobilization exercises.

MATERIALS AND METHODS

This prospective study is an analysis of functional outcome of 20 cases of displaced distal femoral fractures, internally fixed using locking compression condylar plates, which was undertaken at the department of orthopaedics and traumatology at Government Royapettah Hospital, Chennai from May 2005 to September 2007. The Government Royapettah Hospital, is a multispeciality tertiary care referral and trauma centre with an average bed strength of about 700 and 110 beds allotted for orthopaedics and is situated in the heart of the city. We have a 24 hours emergency casualty, running all 365 days a year and fully equipped to tackle both medical and surgical emergencies, with an emergency operation theatre.

In our study of the 20 patients, 14 were Males, 6 were Females. (Table-I).

Table – I

SEX DISTRIBUTION

S. No.	Sex	No. of Patients	Percentage (%)
1	Males	14	70
2	Females	6	30

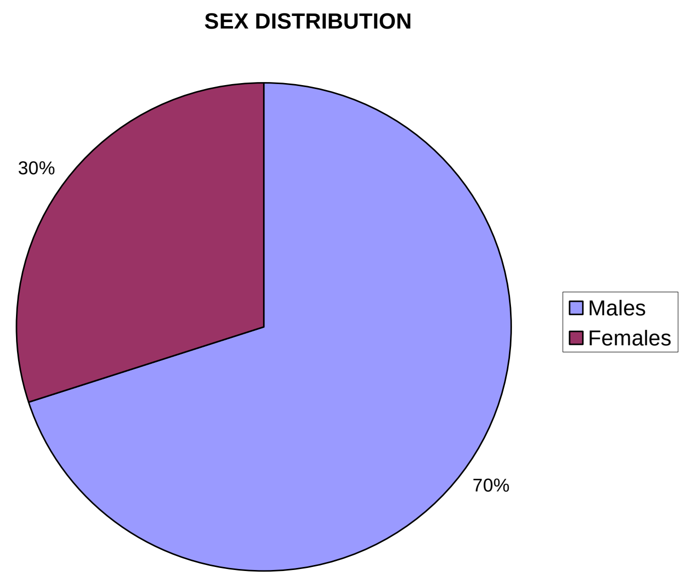
The age of the patients ranged from 20 years to 66 years (Table-II)

Table – II

AGE DISTRIBUTION

S.No.	**Age Group**	**No. of Patients**	**Percentage** (%)	**Males**	**Females**
1	0-10	0	0	0	0
2	11-20	0	0	0	0
3	21-30	7	35	7	0
4	31-40	3	15	2	1
5	41-50	3	15	2	1
6	51-60	3	15	2	1
7	61-70	4	20	1	3

The mode of injury was road traffic accident in 12 patients (60 %), fall from height in 5 patients (25 %) and other modes in 3 patients (15 %).


SEX DISTRIBUTION
30%
70%
Males
Females

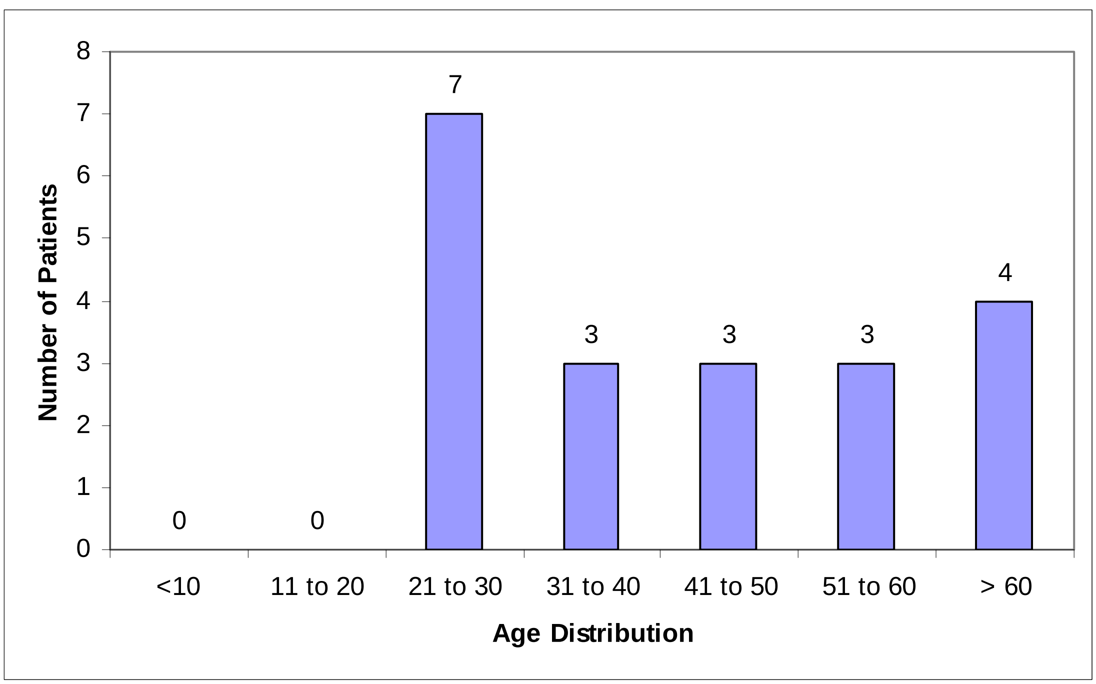

8
7
6
5
4
3
2
1
0
Number of Patients
7
4
3
3
3
0
0
<10
11 to 20
21 to 30
31 to 40
41 to 50
51 to 60
> 60
Age Distribution

Table – III

OCCUPATION

S.No.	Occupation	No. of Patients
1	Labourer	4
2	Student	4
3	House wife	5
4	Skilled worker	4
5	Business	3

Table – IV

SIDE OF AFFECTED LIMB

S.No.	Side involved	No. of Patients
1	RIGHT LIMB	5
2	LEFT LIMB	15

- 16 patients presented to us within one week after injury, 3 patients had taken native treatment earlier and presented after 2 months, and one patient had DCS implant failure (done elsewhere).

- Meticulous clinical examination was made in all patients and associated injuries were treated with proper documentation.

Table – V

ASSOCIATED INJURIES

S.No.	Associated Injuries	No. of Patients
1	Distal Radius fracture	2
2	Metatarsal fracture	2
3	Tibial Condyle fracture	1
4	Tibial shaft fracture	1

Table – VI

FRACTURE CLASSIFICATION

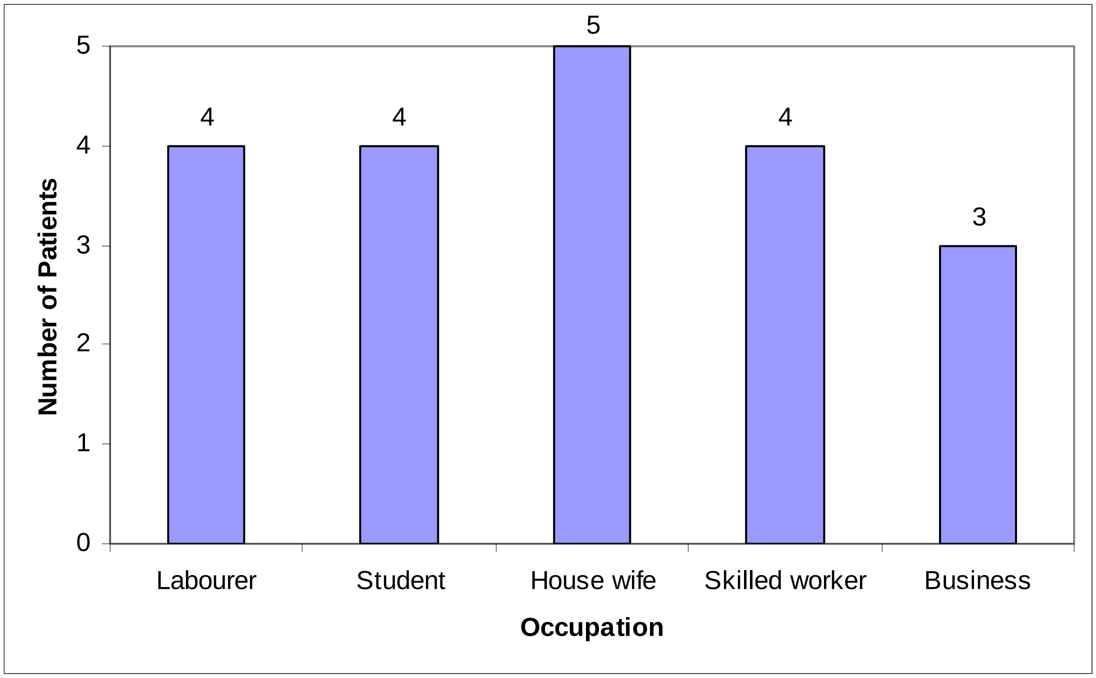
S.No.	Fracture Classification (OTA) Distal femur	No. of Patients
1	C2	11
2	C1	3
3	A1	2
4	A2	1
5	A3	3

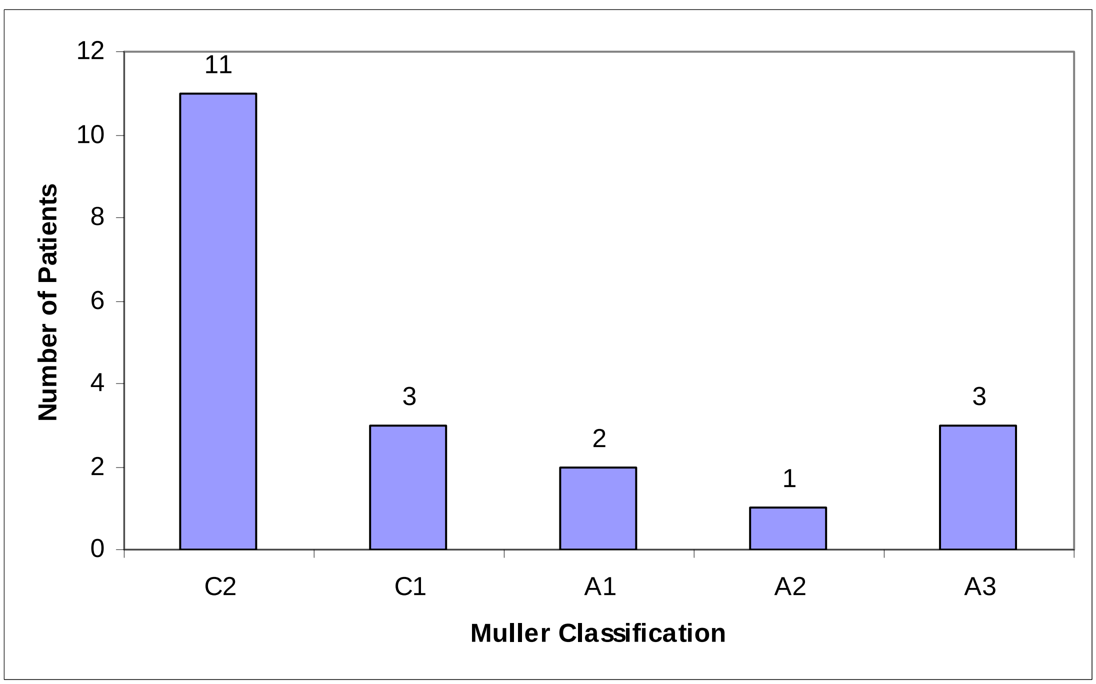
Table – VII

CLOSED Vs OPEN FRACTURE

S.No.	Fracture	No. of Patients	Percentage (%)
1	Closed	16	80
2	Open	4	20

All the four, open fractures included in this study were of grade II according to (Gustilo - Anderson's classification)


Number of Patients
Occupation
Labourer
Student
House wife
Skilled worker
Business
0
1
2
3
4
5
4
4
5
4
3


Number of Patients
Muller Classification
C2
C1
A1
A2
A3
0
2
4
6
8
10
12
11
3
2
1
3

Standard antero-posterior, lateral and oblique radiographs of the affected extremity were taken covering the distal femur with knee. Further evaluation included, radiographs of whole of the hip with thigh (affected) and X-ray pelvis with both hips A.P. and x-ray of ipsilateral leg A.P. & LATERAL. Any other relevant x-rays were ordered accordingly. CT scan was done in 2 patients who had severe intra articular comminution, to delineate the fracture line and pattern of involvement, with position of the fragments[6,7].

All patients with displaced, comminuted fractures and medically fit were subjected to surgery which consisted of open reduction and internal fixation with locking compression plate with / without autogenous bone grafts.

OPERATIVE STEPS

Under appropriate anaesthesia, we used the standard lateral approach to distal femur, with patient in supine position and a sand bag was kept below the operating knee and one below the ipsilateral hip.

- Skin and subcutaneous tissue were cut, the fascia lata was incised, superior geniculate vessels were isolated. All bleeders were cauterized, later using bone spikes the fracture site was reached and the articular fragments were reduced temporarily with pointed reduction forceps and/or K wires.

- We secured the condyles with **6.5 mm** cancellous screws. A condylar plate guide or plate itself was held laterally on the condyle to select an area where screws will not interfere with plate placement.

- Then a K wire was placed across the femoral condyle, at the level of the knee to indicate the joint axis and place a second K wire across the patello-femoral joint on the trochlear surface.

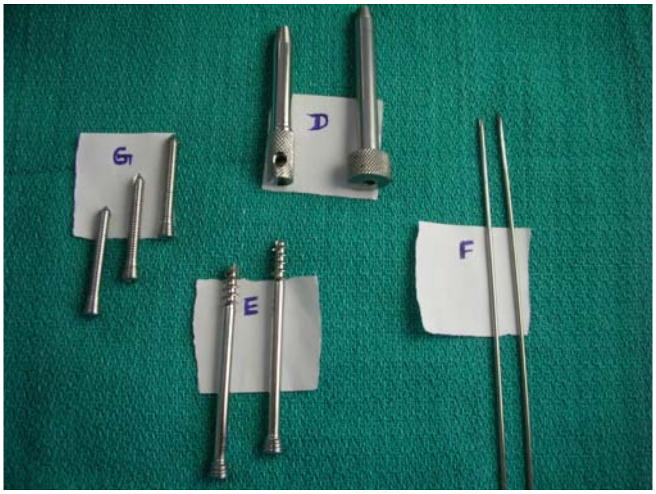
- Using anatomic landmarks and C – arm imaging, we mounted the plate on the intact / reconstructed condyle without attempting to reduce the proximal portion of the fracture.

- Final check was made as to, whether the guide wire inserted in through the central hole was parallel to both distal femoral joint axis and patello - femoral joint.

- Screw length determined using measuring device. Screws inserted starting from central hole in the condylar portion and was checked under image control and subsequent screws were inserted.

- Once reduction was satisfactory, the plate shaft was fixed with appropriate cortical screws after confirming final reduction of the fracture.

IMPLANTS



Implants

The locking condylar plates used for distal femur has side differentiation and are precontoured and provided with combi-hole pattern of various sizes:

A & B - LOCKING CONDYLAR PLATES (LEFT / RIGHT)

C - DRILL BIT

D - LOCKING GUIDES / SLEEVES

E - CANCELLOUS LOCKING SCREWS, PARTIALLY THREADED

F - 2 MM KIRSCHNER (K) WIRES

G - CORTICAL LOCKING SCREWS

H - SCREW DRIVER WITH HEXAGONAL TIP

Postoperative care and Rehabilitation

- Post operative care in the form of intravenous antibiotics and periodic change of dressings were done. The suction drain was removed after 48 hours, and sutures were removed at 12^{th} postoperative day.

- Rehabilitation was custom made to each patient and gentle knee mobilization was started on 3rd postoperative day, emphasizing quadriceps strengthening and hamstring stretching exercises and gentle hip and ankle mobilization were started.

- Continuous passive motion was advised for selective cases, who had presented late and had knee stiffness earlier. We recommended using at a rate of 1 cycle /minute, with 40 degrees of maximum flexion, for first 1 week.

- Non weight bearing with walker support was started at the end of 1st week.

- Full weight bearing was allowed only after radiological evidence of union[20].

- All patients were followed; at regular intervals and evaluated for fracture healing and any change in alignment, screw breakage were monitored. Femoral alignment was assessed by measuring the angle created by a line drawn along the femoral shaft and one drawn parallel to the femoral condyles, with 5° of valgus considered to be normal. The lateral radiograph was evaluated for procurvatum or recurvatum with use of lines drawn along the main fragments[17,20].

- **Clinical union** was defined as a painless fracture site during full weight-bearing[17,20].

- **Radiographic union** was defined as bridging trabeculation across the fracture line(s) on three of four cortices seen on orthogonal projections in absence of migration, loosening, or breakage of hardware[17,20]. **Functional outcome was measured using Neer et al, functional scoring system[1,3].**

OBSERVATIONS

- Majority of injured patients were males (70%)
- Highest number of patients were in their 3rd decade (35%)
- Road traffic accident was the most common mode of injury (60%)
- There was not a single case with bilateral fractures
- 2 patients had associated distal radius fracture, 2 patients had ipsilateral metatarsal and phalangeal bones fracture, one patient had ipsilateral tibial condyle and one patient had ipsilateral tibial shaft fracture making a total of 6 patients (30%) with associated fractures
- Most of the patients, reported within 1st week of injury to the hospital.
- 16 out of 20 patients had closed injury
- Type C2 muller’s fracture was the most common fracture type 11 out of 20 patients (55%).
- The shortest follow up period was 3 months and the longest follow up period was 20 months.

- The average range of knee flexion achieved was about 92°.
- Maximum gain in knee flexion was 110° and minimum gain about 80°.
- The average knee score 79.55% was rated using NEER functional score.
- Early complications were encountered in 4 patients and these were superficial wound infection, wound gaping, pin site infection and mild transfusion reaction.
- Late complications were observed like mal-union with varus in 4 patients, screw breakage in 1 patient, knee stiffness in 2 patients.
- The average stay in hospital was about 14 days.
- Postoperative immobilization with knee brace was advised for severely comminuted fractures, for 3 weeks, although gentle physiotherapy exercises were started earlier.
- Autogenous ipsilateral fibular strut graft was used in one patient and autogenous iliac crest grafts were used in 16 out of 20 patients.

RESULTS

- All patients were followed at regular intervals (ie., once in a month for the first 3 months and once every 3 months thereafter).

- The minimum follow up period was 3 months and the maximum followup was 20 months. The mean followup period in this study was 8.46 months.

The results were evaluated by taking into consideration the following factors:

1. Pain
2. Function
3. Motion
4. Work
5. Gross Anatomy and
6. Roentgenograms

NEER'S FUNCTIONAL SCORING was used to assess the outcome of surgery, for adult distal femoral fractures[1,3].It consists of :

Functional (70 units) and Anatomic (30 units)

Table I

Pain (20 units)	Unit value
5-No pain	20
4-Intermittent	16
3-With fatigue	12
2-Restrict function	8
1-0 constant or at night	4 -0

In our observation, 10 out of 20 patients had no pain (50%), 6 patients had intermittent pain due to knee stiffness (30%), 4 patient had pain with fatigue. (20%)

Table II

Function (20 units)	Unit value
5-As before injury	20
4-Mild restriction	16
3-Restricted, stairs sideways	12
2-Cane or severe restriction	8
1-0 Crutches or brace	4 -0

In our study, 12 out of 20 patients were able to return to their function as before injury. Mild restriction was noted in rest of 6 patients, restriction with stair climbing in 2 patients.

Table III

Motion (20 units) Knee Flexion	**Unit value**
5-Normal or 135 degrees	20
4 100 degrees	16
3 80 degrees	12
2 60 degrees	8
1 40 degrees	4
0 20 degrees or less	0

In our observation, 10 out of 20 patients gained knee flexion of 100° or more, 2 patients gained upto 90° and Remaining 8 patients averaged a knee flexion of 80°.

Table IV

Work (20 units)	**Unit value**
5 As before injury	10
4 Regular but with handicap	8

3 Alter work	6
2 Light work	4
1-0 No work	2-0

In our observation, 12 patients worked as before injury, 4 patients with mild handicap and 4 patients shifted to alter work.

Table V

Gross Anatomy (15 units)	**Unit value**
5 Thickening only	15
4 5 degrees angulation or 0.5 cm short	12
3 10 degrees angulation or rotation, 2.0 cms short	9
2 15 degrees angulation or rotation, 3.0 cms short	6
1 union but with greater deformity	3
0 non union or chronic infection	0

In our study, 4 patients developed mild varus angulation of 5° and another 4 patients had 10° varus with shortening subsequently (2 cms), and the remaining patients had thickening only.

Table VI

Roentgenogram (15 units)	Unit value
5 Near Normal	15
4 5 degrees angulation or 0.5 cm displacement	12
3 10 degrees angulation or 1.0 cm displacement	9
2 15 degrees angulation or 2.0 cms displacement	6
1 Union but with greater deformity; spreading of condyles; osteo-arthritis	3
0 Nonunion or chronic infection	0

Out of 20, 12 patients had near normal radiographs, 4 had 5 degrees angulation and another 4 points had 10 degrees angulation.

Table VII

Overall Rating

Excellent	Above 85 units
Satisfactory	70-85 units
Unsatisfactory	55-69 units
Failure	Below 55 units

Overall results were excellent in 9 out of 20 cases and were good to satisfactory in remaining cases. The overall average knee score in our study was 79.55%[1,3].

ILLUSTRATIVE CASES

CASE - I

A 40 years old male, mr. A, met with an accident while driving a two wheeler and sustained type C2 Muller's fracture of distal femur left side with ipsilateral schatzker's type IV (medial tibial condyle fracture). He presented to us on the day of injury. Patient was hemodynamically stabilized and the left lower limb was supported in a Thomas aplint with skin traction. On 3rd day, the patient underwent open reduction and internal fixation with locking condylar plate for distal femur and cancellous screw fixation for tibial plateau fracture at the same sitting. Patient had an uneventful postoperative period.

At the end of 1st week, gentle quadriceps exercises were started, knee and ankle movements were encouraged and non weight bearing walking for next 3 weeks. The patient was followed at monthly intervals and full weight bearing was allowed after radiologic confirmation of union at end of 4 months.

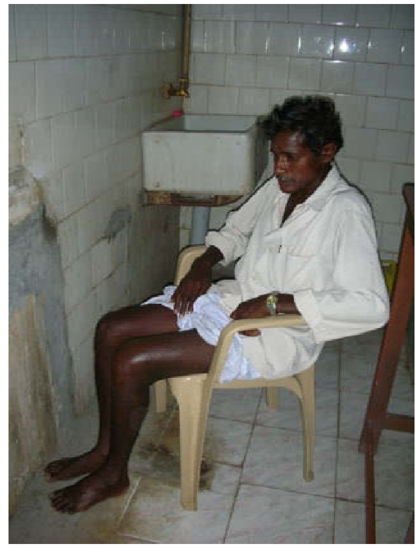
CASE I

PRE OP X RAYS

IMMEDIATE POST OP

FOUR MONTHS POST OP

FUNCTIONAL OUTCOME



CASE – 2

A 28 years old Male, Mr. D, met with a road traffic accident, while traveling in a two-wheeler and sustained injury to left thigh and sustained Muller's type A1 fracture, (closed). There were no associated injuries. Patient initially took native treatment for 2 months in the form of splints & bandages and presented late to us.

Earlier, patient was put on skeletal traction for 2 weeks and was operated and internally fixed using condylar LCP with autogenous bone grafting. Pt. had an uneventful postoperative period. CPM was started in the first week and patient was discharged after suture removal on 12^{th} day.

Pt was taught knee and ankle mobilization exercises and strict non weight bearing for 6 weeks and was reviewed at periodic intervals. Radiological union was confirmed at end of 5 months and patient had a good functional outcome.

CASE II PRE OP


IMMEDIATE POST OP

FIVE MONTHS POST OP


FUNCTIONAL OUTCOME

CASE – 3

A 28 years old Male, Mr.K, met with a road traffic accident, while driving a motorcycle and sustained injury to left thigh. Patient was initially admitted at a private hospital and was diagnosed to have closed A3 Muller's supracondylar # femur and open reduction and internal fixation with DCS plate was done. At end of 3 months, radiographs showed varus collapse of fragments with loss of reduction and loosening of the implant.

Later, at the end of 4 months, patient presented to us with inability to stand / walk and had persistent pain. We operated on him, whereby the DCS implant was removed and fixed with LCP condylar plate with bone grafting. Patient had uneventful postoperative period.

We followed the same rehabilitation protocol and radiological union was confirmed at end of 6 months. Now, the patient walks unaided with good range of knee movements.

CASE III

PRE OP

IMMEDIATE POST OP

SIX MONTHS POST OP

FUNCTIONAL OUTCOME

CASE – 4

Mr.G, 22 years old college student, was admitted at our hospital following a fall from a motorcycle. He was diagnosed to have gustilo grade 2 open fracture[21,22], Muller's type C2 # of distal femur. Patient was hemodynamically stabilised and thorough wound wash and debridement was carried out in minor theatre. There was no other associated injury. Patient was put under intravenous antibiotics and a second look of wound was made after 48 hours, wound swab taken for culture and sensitivity reported negative. Patient was taken up for definitive surgery on 5th day. We did open reduction, internal fixation with LCP condylar plate and K wires with ipsilateral fibular strut graft with corticocancellous iliac bone graft. Intravenous antibiotics were continued for two weeks, except for superficial wound infection overall postoperative period was uneventful.

Pt. had regular follow up and rehabilitation program and union was achieved at 5th month and we now have 11 months follow up, with good range of knee movements.

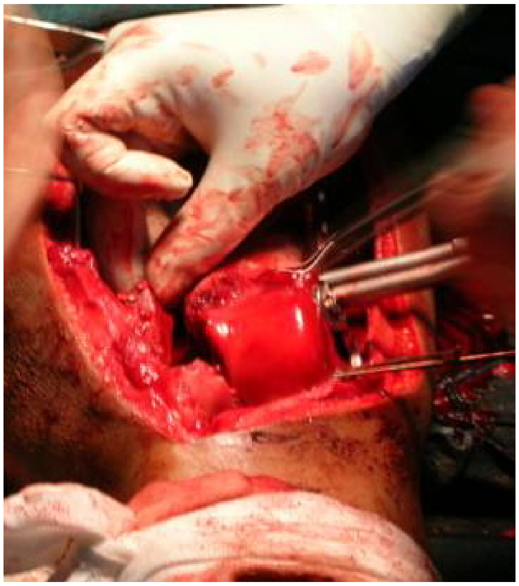
CASE IV

PRE OP

IMME.

11 Mon.

INTRA OP



FUNCTIONAL OUTCOME

CASE - 5

Mr.B, 23 years old, student, had a fall at stairs and injured his left thigh. Patient being a victim of postpolio residual paralysis, affecting his lower limbs was ambulant independently with crutch support, prior to the accident. Radiographs showed type A1 Muller's # of distal femur (closed #).Pt was taken up for surgery on 3rd day after admission, was internally fixed with LCP condylar plate. Patient had uneventful postoperative period and returned to his activities by the 4th month.

PRE OP **IMME.**

6 MONTHS POST OP

6 MONTHS POST OP

FUNCTIONAL OUTCOME

CASE – 6

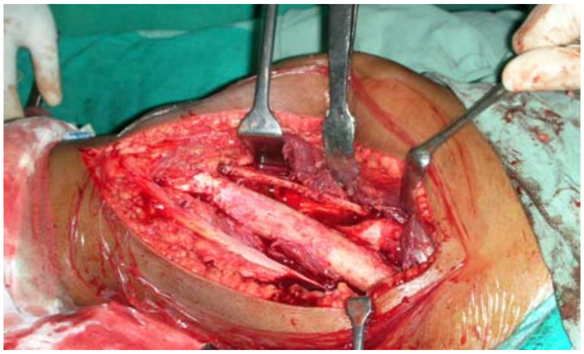
Mrs. K, 65 years old, house wife presented after a fall from height with closed injury to left lower thigh. She was diagnosed to have type C1 Muller's # of distal femur on left side. Patient was a known diabetic and hypertensive and hence skeletal traction was applied in left upper tibia, initially. We operated on the 10^{th} day after admission and after obtaining medical fitness. Open reduction and internal fixation using condylar LCP was done. Patient had uneventful postoperative period except for pin site infection and radiological union was confirmed by the end of 3 months.

CASE VI

PRE OP

3 MONTHS

OUTCOME



POSTOPERATIVE COMPLICATIONS

- Early complications were encountered in 4 patients. One patient, developed superficial wound infection in 1^{st} week and was promptly treated with appropriate antibiotics, wound care and secondary suturing.

- One patient, developed pin site infection (upper tibia), where skeletal traction was applied preoperatively.

- One patient developed wound gaping, due to post operative edema, which was treated by secondary suturing.

- One patient developed mild transfusion reaction (anticoagulant induced), which was treated immediately with antihistamines.

Early complications

S.No.	Complications	No. of patients
1	Superficial wound infection	1
2	Pin site infection (upper tibial)	1
3	Wound gaping	1
4	Mild transfusion reaction (anti-coagulant, induced)	1

Late

- Late complications included knee stiffness in 2 patients, in one of whom it was observed that an anterior cortical spike from distal femur irritated his quadriceps mechanism. He was taken up for 2^{nd} surgery and anterior cortical spike was removed and pericapsular adhesions were released, followed by regular physiotherapy using C.P.M. machines, which improved his knee flexion from 40° to 90°. The other patient was treated conservatively with physiotherapy exercises.

- One patient presented with broken screw in the condylar region, in his 9^{th} month and subsequently developed pain due to prosthesis loosening and the implant was removed 1 year post surgery, after achieving good union.

- Four patients were noticed to have varus collapse of about 10° with malunion.

Late Complications

S.No.	Complications	No. of patients
1	Malunion with varus	4
2	Screw breakage	1
3	Knee stiffness	2

INFECTION

KNEE STIFFNESS

SCREW BREAKAGE

DISCUSSION

The use of locked plates and percutaneous techniques have evolved together while remaining true to the AO principles of internal fixation. The overlying principle is to preserve the blood supply and minimize soft tissue injury.

High energy distal femoral fractures are frequently associated with articular fracture and metaphyseal comminution[1,2,3]. Coronal plane fracture and extensive distal comminution generally preclude the use of traditional fixed-angle devices or retrograde nails[11]. Earlier, fixation of these fractures with a lateral plate alone has historically been associated with non-union and /or malunion with varus collapse. Prior to advent of locking plates, these problems were addressed with dual plating methods[5].

With the introduction of plates with option of locked screws, the results are encouraging, as it increases the rigidity of fixation in osteoporotic bone and in presence of periarticular or juxta-articular comminution.[(12,13,17).] The LCP condylar plates provide multiple points of fixed plate to screws contact, generating greater stability and thereby reducing the tendency of varus collapse.[(17,18)] LISS plating allows minimally invasive approach by submuscular insertion of plates and thereby preservation of vascularity to the lateral cortex.

We attributed the favourable results in this series by adherence to the principles of stabilization, with rigid internal fixation and early functional rehabilitation. Bone grafting was considered critical for rapid union of comminuted fractures.[(15,16).] None of our patients had loss of fixation or an aseptic non-union, despite large numbers of comminuted fractures, elderly people and open fractures. Also the incidence of mal-union was low, as only four patients had 10 degree of varus mal-alignment.[(21)]

In our study, radiological union was seen at an average of 15.7 weeks which is comparable to study of LISS plates[7,8,9] by Max Markmiller, et al, CORR, 2004, that averages 13.8 weeks.[(8).] Overall results were good to excellent in 9 out of 20 cases and were satisfactory in remaining cases. The overall average knee score in our study was 79.55%, as apposed to 81% in J.M. Siliski et al, study, JBJS.[(3)]

The problems in fixing distal femoral fractures with osteoporosis, extensive comminution and revision surgeries following failed implant can be addressed effectively using locking condylar plate.[(12,16,18).]We believe that locking plates represent a valuable advancement in fracture treatment. However, the limitations of this new technology and indications for its use have not been completely elucidated and the long-term results are awaited.

However, the locking plates can fail when physiological loads are outside plate-design parameters.[10,17]. The locked screws can dis-engage from the plate secondary to failure of the screw to seat into the plate properly, as a result of cross – threading or when insufficient screw torque is used to engage the screw threads into the plate threads.[10,17]

CONCLUSION

The LCP condylar plate is a valuable addition in the armamentarium of the orthopaedician in the management of comminuted distal femoral fractures, with questionable bone integrity. It may not completely solve the age old problems associated with any fracture like non union and malunion, but is a valuable technique in management of these fractures. This technique is not bereft of complications like plate or screw breakage, but careful selection of patients and strict adherence to the basic principles of fracture fixation will go a long way in reducing the complications of fracture fixation using locking compression plates.

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MASTER CHART

S.No.	Name	Age/Sex	Mode of Violence	Type of Fracture (OTA)	Associated Injuries	DOA	DOS	Initial Treatment	Definitive Treatment	Union in weeks	ROM Knee Flexion	Knee Score	Complications	Follow up (months)
1	Babu	23/M	Fall At stairs	A1 Closed (L)	NIL	14.2.07	16.2.07	Thomas splint, skin traction	ORIF with LCP	16	0°-100°	86	NIL	7
2	Gopi	22/M	RTA	C2 Grade II Open (L)	NIL	26.7.06	3.8.06	UTPT	ORIF with LCP + Fibular strut +BG	20	0°-100°	87	Superficial wound infection	13
3	Kathirvel	28/M	RTA	A3 Closed (R)	NIL	26.3.07	29.3.07	High AK	Implant removal ORIF with LCP +BG	16	0°-100°	86	NIL	6
4	Panneer Selvam	21/M	RTA	C2 Closed (L)	NIL	24.7.06	1.8.06	Thomas splint	ORIF LCP + BG + 2nd surgery Ant-corticotomy	16	0°-90°	71	Early Knee Stiffness	14
5	Srinivasan	55/M	Fall from height	C2 closed (L)	NIL	2.6.06	8.6.06	Thomas splint	ORIF with LCP +BG	18	0°-80°	71	Screw Breakage	15
6	Venkatesan	28/M	RTA	C2 Grade II open (R)	Metatarsal # 2, 3rd (R)	1.6.07	14.6.07	UTPT	ORIF with LCP + BG	16	0°-80°	76	Wound infection	5
7	Annamalai	40/M	RTA	C2 closed (L)	Metastarsal # 2, 3rd (L)	15.5.07	23.5.07	UTPT	ORIF with LCP	16	0°-90°	86	NIL	5

S.No.	Name	Age/Sex	Mode of Violence	Type of Fracture (OTA)	Associated Injuries	DOA	DOS	Initial Treatment	Definitive Treatment	Union in weeks	ROM Knee Flexion	Knee Score	Complications	Follow up (months)
8	Shanti	38/F	Fall from height	C1 closed (L)	NIL	6.9.06	12.9.06	Thomas splint	ORIF with LCP + BG	16	0°-80°	74	NIL	12
9	Devadoss	28/M	RTA	A1 closed (L)	NIL	16.4.07	26.4.07	UTPT	ORIF with LCP + BG	20	0°-100°	80	NIL	6
10	Kuppammal	65/F	Fall from Height	C1 closed (L)	NIL	9.7.07	19.7.07	UTPT	ORIF with LCP + BG	12	0°-100°	86	Pin site infection	3
11	Mohd. Arif	40/M	RTA	C2 closed (L)	Type IV schatzker's (L) tibia	6.7.05	11.7.05	Thomas splint+skin traction	ORIF with LCP+cancellous screw + BG	16	0°-110°	89	NIL	20
12	Saradambal	53/F	RTA	A2 closed (R)	Distal radius # (R)	10.4.07	25.4.07	UTPT	ORIF with LCP	14	0°-80°	74	NIL	5
13	Chellam	65/F	Fall at bathroom	C2 closed (R)	Distal radius # (R)	7.3.07	15.3.07	Thomas Splint+skin traction	ORIF with LCP + BG	16	0°-85°	74	NIL	5
14	Muniammal	66/F	RTA	C2 closed (R)	Closed M/3 tibia # (R)	24.4.07	30.4.07	High AK	ORIF with LCP + IM-IL Nailing Tibia	16	0°-80°	71	Mild transfusion reaction	6
15	White	55/M	Fall at stairs	C2 grade II (L) Open	NIL	14.11.06	8.12.06	UTPT	ORIF with LCP+BG	14	0°-80°	70	Superficial wound gaping	10

S.No.	Name	Age/Sex	Mode of Violence	Type of Fracture (OTA)	Associated Injuries	DOA	DOS	Initial Treatment	Definitive Treatment	Union in weeks	ROM Knee Flexion	Knee Score	Complications	Follow up (months)
16	Raju	24/M	RTA	C2 closed (L)	Nil	02.05.07	08.05.07	High AK	ORIF with LCP+BG	12	0°-100°	86	Nil	4
17	Pandian	42/M	RTA	C1 Grade II open (L)	Nil	21.02.07	27.02.07	Thomas splint	ORIF with LCP+BG	14	0°-100°	80	Nil	7
18	Pushpa	48/F	Fall from height	A3 closed (L)	Nil	04.12.06	19.12.06	UTPT	ORIF with LCP+BG	14	0°-105°	87	Nil	9
19	ArokiaRaj	46/M	Fall from height	C2 closed (L)	Nil	09.10.06	17.10.06	UTPT	ORIF with LCP+BG	16	0°-100°	86	Nil	11
20	Mohd. Yusuf	62/M	RTA	A3 closed (L)	Nil	08.09.06	14.09.06	UTPT	ORIF with LCP+BG	16	0°-80°	71	Nil	12

ABBREVIATIONS USED

ACL	-	Anterior Cruciate Ligament
AK	-	Above knee
AP	-	Antero-posterior
BG	-	Bone Graft
CPM	-	Continuous passive motion
CORR	-	Clinical Orthopaedic and Related Research
#	-	Fracture
JBJS	-	Journal of Bone and Joint Surgery
JOT	-	Journal of Orthopaedic Trauma
K wire	-	Kirshner wire
LAT	-	Lateral
LCP	-	Locking Compression Plate
LISS	-	Less invasive stabilization system
ORIF	-	Open reduction and Internal fixation
Pt.	-	Patient
RTA	-	Road traffic accident
UTPT	-	Upper tibial pin traction

PROFORMA

Name :

Age/Sex:

IP No.:

Hospital:

Unit:

Ward:

Address:

Phone No.:

Date of Admission:

Date of Surgery:

Date of Discharge:

Diagnosis:

Procedure:

Clinical Features:

Associated Injuries:

Investigations:

7. Radiographs
8. CT/MRI
9. Blood Investigations
10. Chest X-Ray
11. ECG
12. Others

Advise on discharge

Follow up and Complications

Functional outcome

Treatment and Rehabilitation